

“WP” Norris

- ◆ **NSWC Crane**
- ◆ **2M Program Office**
- ◆ **Code 6083 Bldg 3330 North
300 Hwy 361
Crane, IN 47522**
- ◆ **812.854.3192 FAX: 854.3855
DSN:482**
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Lead-Free Solder

- ◆ Use MAY cause premature failure of CCAs
- ◆ Nearly all CCAs are Sn/Pb
- ◆ Lead residue may contaminate lead-free solder used for rework of Sn/Pb CCAs
- ◆ Contamination may reduce joint strength by as much as 50%
- ◆ Industry studies are conflicting

Rosin Activated (RA) Flux

- ◆ **Must be remove from ANY and ALL areas soldering electronics**
- ◆ **Will cause premature failure**
- ◆ **Corrosive**
- ◆ **Electrically conductive**
- ◆ **Contain zinc and/or ammonium chloride**

Electro Static Discharge Control

**Naval Surface Warfare Center
Crane Division**

WP 004

NAVAIR 01-1A-23

Rev 2

- ◆ **ESD ADV 1.0 - 1994**
Electrostatic Discharge Terminology Glossary
- ◆ **ANSI / ESD S20.20 - 1999**
**ESD Association Standard for the
development of an Electrostatic Discharge
Control Program**
- ◆ **ESD - TR20.20 - 2000**
**ESD Association Technical Report for the
Development of an Electrostatic Control
Program for the Protection of Electronic Parts,
Assemblies and Equipment**

www.esda.org





History of Static Electricity

- ◆ **Lightning has been observed since the dawn of man.**
- ◆ **First recorded experiments: 600 b.c.**
- ◆ **Studied extensively: 16th & 17th centuries.**
- ◆ **First Electronic Failures: 1940s.**

Static Problems in Industry

Petroleum Industry

Charges generated by trucks, ships, barrels, pipes, etc.

Lightning Damage

Various

Automobile Shocks

Touching handles or people

Toll Booths

Toll booth attendees / drivers

Medical Industry

Oxygen explosions / shocks

Explosive Industry

Critical problem

Aircraft Static Buildup

Concern for explosions

Grain Elevators

Explosions ?????

ELECTRONICS INDUSTRY

REMAINDER

Reasons for Disbelief

- ◆ **Most ESD damage occurs below human sensitivity level ($< 3500\text{ V}$)**
- ◆ **Many subtle damage paths**
- ◆ **Assorted parts affected**
- ◆ **Damage often invisible under microscope**
- ◆ **Sophisticated analysis necessary**

Problem Estimates

- ♦ **Dick Moss - Hewlett Packard**
 - » **All component failures:**
 - » **5 to 25% ESD caused**
- ♦ **Burt Unger - Bell Labs**
 - » **Dead on arrivals:**
 - » **50% ESD caused**
- ♦ **Lou DeChario - Bell Labs**
 - » **Early life operating failures:**
 - » **> 50% ESD caused**

Type Defects

- ◆ **Catastrophic failure**
 - **device doesn't work**
- ◆ **Latent defect**
 - **passed acceptance testing but is defective or degraded**
 - **most costly defect**
 - **possible weapon systems failure**

\$ \$ \$ Estimates

- ◆ **In manufacturing environment estimating is an easy process because of increased yields.**
- ◆ **In repair facilities estimates are difficult to evaluate.**
- ◆ **But in both environments the savings are in the billions of dollars per year.**

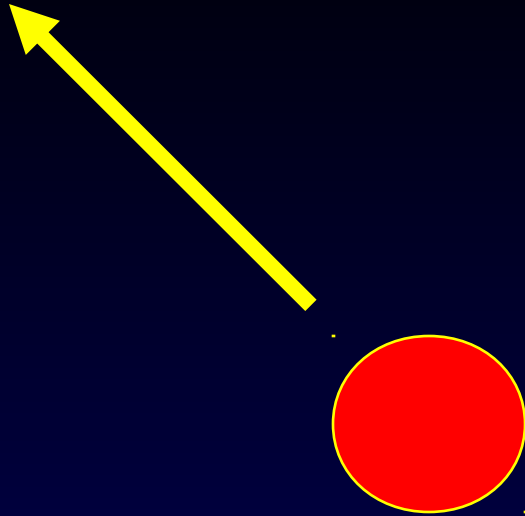
Static Electricity

**Stationary electrical charges
or
Electrical charges at rest**

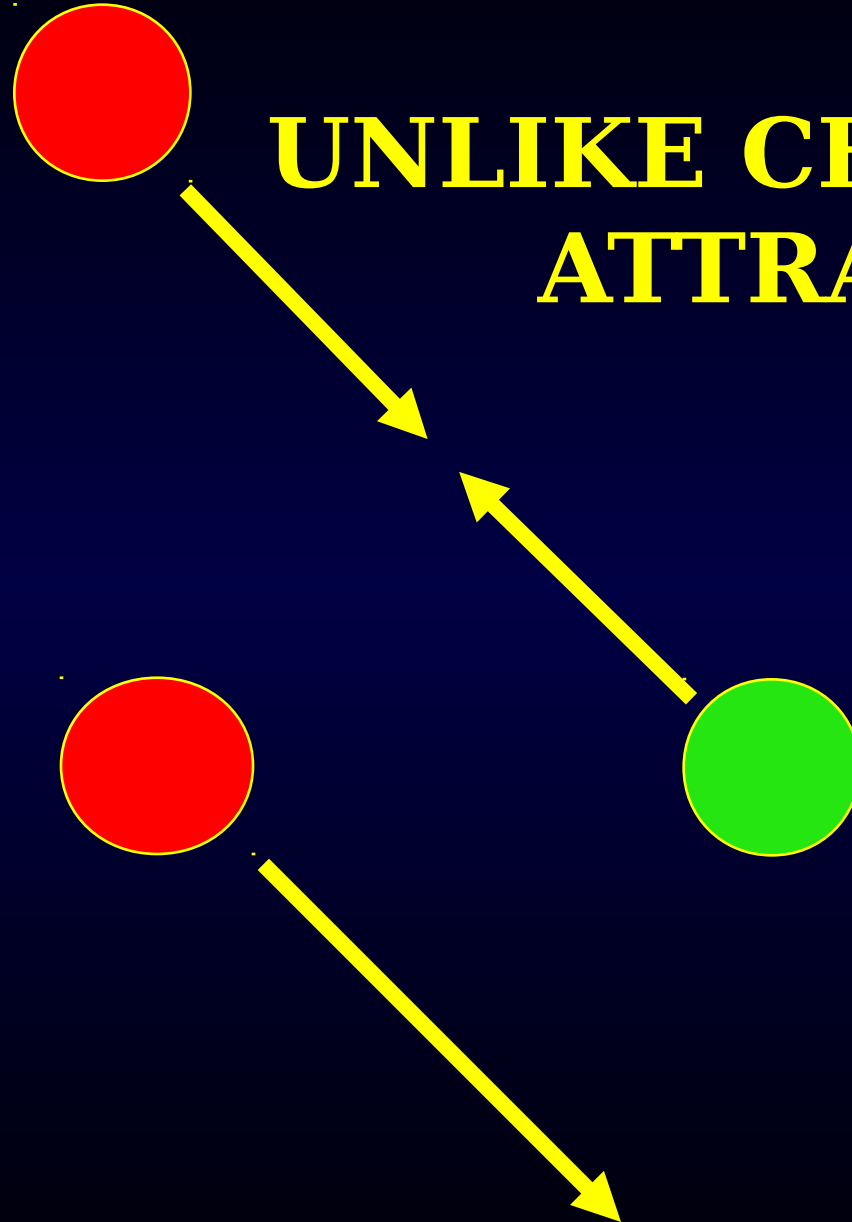
Factors Affecting Static Charge Generation

- ◆ **Intimacy of contact**
- ◆ **Speed of separation**
- ◆ **Conductivity of materials**
- ◆ **Triboelectric series**

**LIKE CHARGES
REPEL**

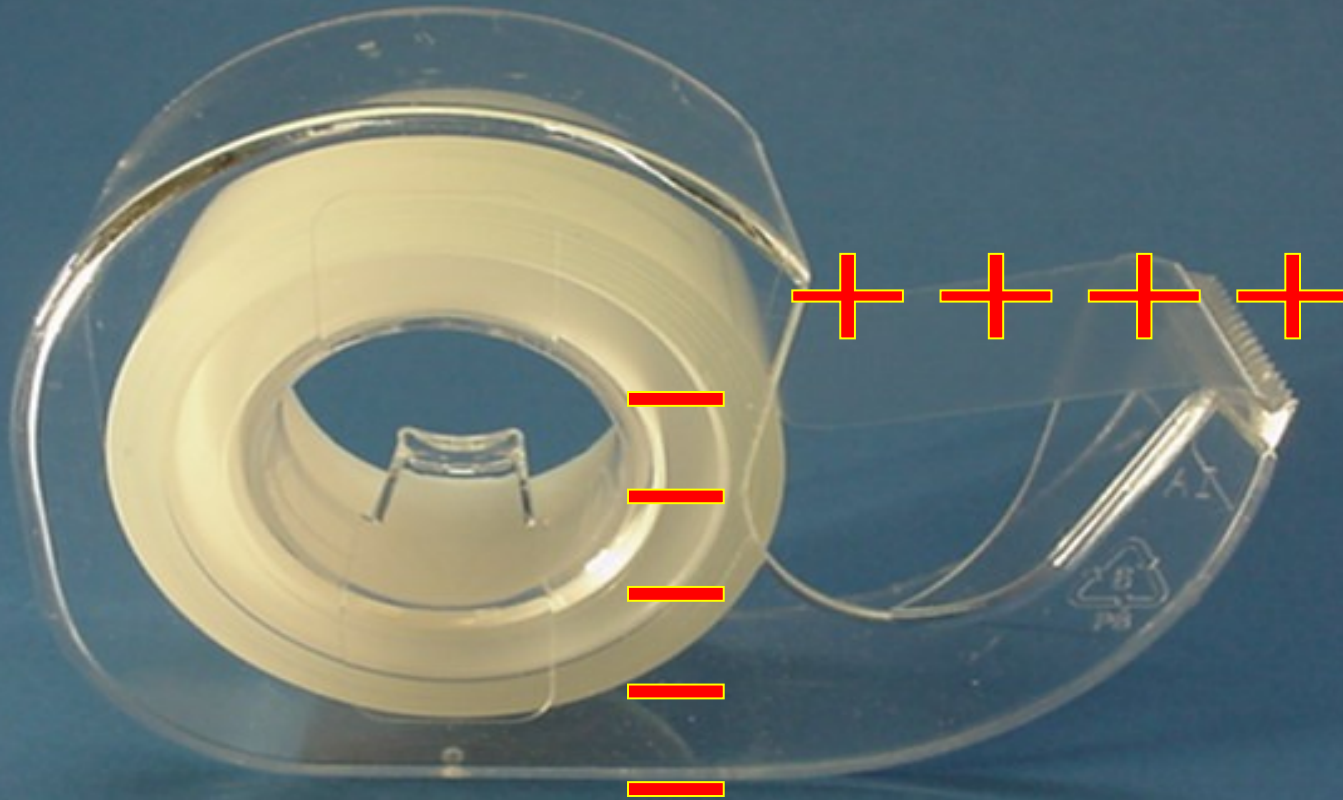


**UNLIKE CHARGES
ATTRACT**



Charge Generation

Intimacy of Contact

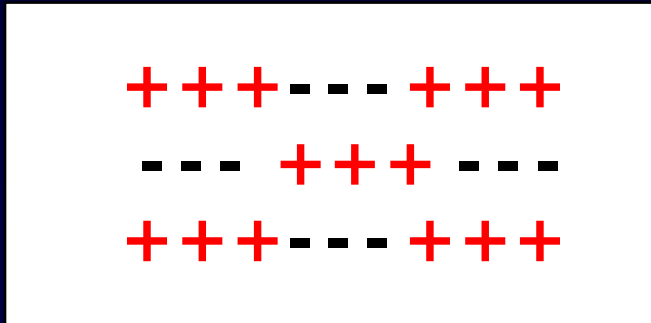


Speed of Separation

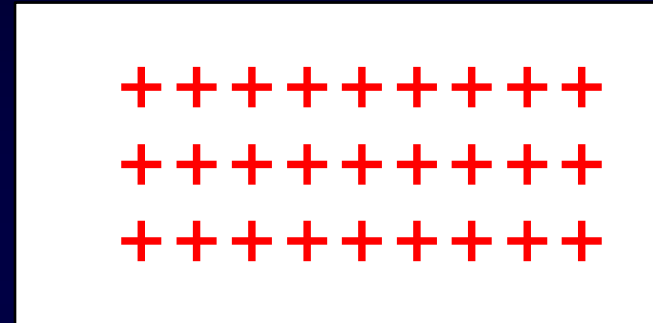
- ♦ **A Conductor allows the flow of electrons**
- ♦ **An Insulator restricts the flow of electrons**

CONDUCTIVITY OF MATERIALS

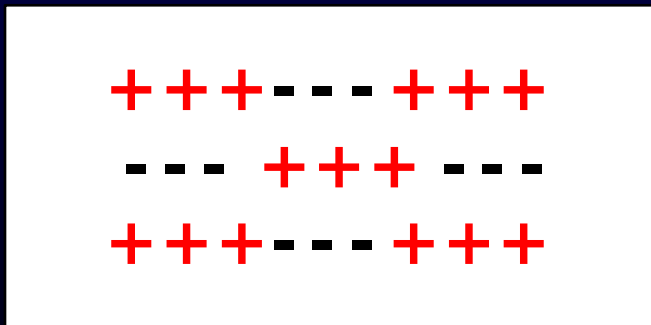
NON-CONDUCTOR



ISOLATED CONDUCTOR



NON-CONDUCTOR



GROUNDING CONDUCTOR



Electrostatic Field

**Lines of force present
around a charged body**

Electro Static Charges

- ♦ To feel it --- 3,500 Volts or more required
- ♦ To hear it -- 4,500 Volts or more required
- ♦ To see it -- 5,000 Volts or more required
- ♦ Static cling - 7,500 Volts or more required

Typical Prime Charge Sources

PACKAGING AND HANDLING

- ♦ **Common plastic bags, wraps, envelopes.**
- ♦ **Common bubble pack, foam.**
- ♦ **Common plastic trays, plastic totes, boxes, vials, parts bins, tape.**

ASSEMBLY, CLEANING, TEST & REPAIR AREAS

- ◆ **Spray cleaners**
- ◆ **Common plastic solder suckers**
- ◆ **Soldering irons with ungrounded tips**
- ◆ **Brushes (synthetic bristles)**
- ◆ **Temperature chambers**
- ◆ **Cryogenic sprays**
- ◆ **Heat guns and blowers**
- ◆ **Sandblasting**
- ◆ **Electrostatic copiers**

CLOTHES

- ◆ **Common clean room smocks**
- ◆ **Common synthetic personnel garments**
- ◆ **Nonconductive shoes**
- ◆ **Virgin cotton**
 - **at very low humidity**

WORK SURFACES

- ◆ **Waxed, painted, or varnished surfaces**
- ◆ **Common vinyl or plastics**

CHAIRS

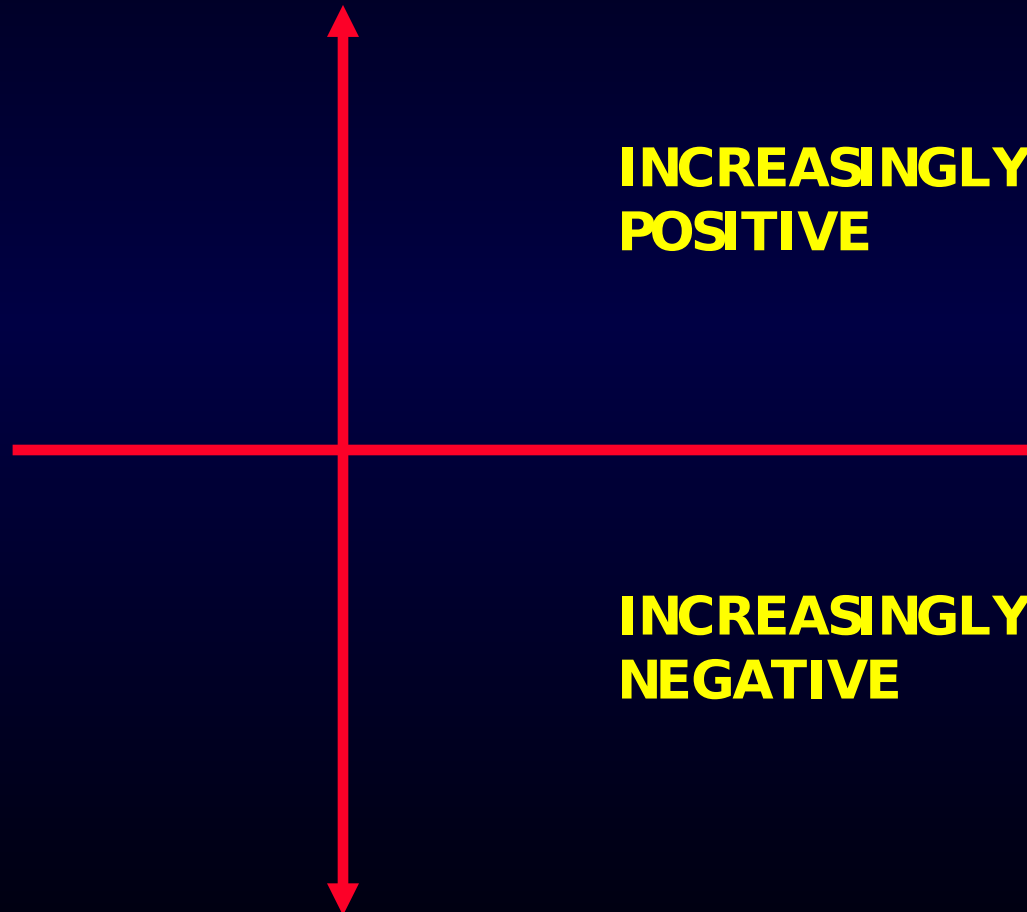
- ♦ **Finished wood**
- ♦ **Vinyl**
- ♦ **Fiberglass**

FLOORS

- ◆ **Sealed concrete**
- ◆ **Waxed, finished wood**
- ◆ **Common vinyl tile or sheeting**

TRIBOELECTRIC SERIES

AIR
HUMAN SKIN
GLASS
HUMAN HAIR
WOOL
FUR
PAPER
COTTON
WOOD
HARD RUBBER
RAYON
POLYESTER
POLYURETHANE
PVC (VINYL)
TEFLON



Typical Charge Levels

- ◆ Personnel - 1.5 KV to 20 KV
- ◆ Plastic materials - 2 KV to 35 KV

Typical Electrostatic Voltages

Means of Static Generation	10 - 20% Humidity	60 - 90% Humidity
Walking across carpets	35,000V	1,500V
Walking over vinyl floor	12,000V	250V
Worker at bench	6,000V	100V
Vinyl envelopes for work instructions	7,000V	600V
Common poly bag picked up from bench	20,000V	1,200V
Work chair padded with polyurethane foam	18,000V	1,500V

WHAT WE DON'T FEEL:

- ♦ **ESD < 3,500 Volts**
(But the circuit cards do)

Static Susceptibility of Semiconductor Devices

Device Type	Range of Susceptibility (Volts)
MOS / FET	100-200
J -FET	140-7,000
CMOS	250-3,000
SCHOTTKY DIODE	300-2,500
SCHOTTKY TTL	1,000-2,500
BIPOLAR TRANSISTORS	300-7,000
ECL HYBRID	500-1,500
OP-AMP	190-2,500
SCR	600-1,000

DANGER

- ♦ **Some devices may be damaged with voltages as low as 5 - 10 Volts**

**If we did not
have insulators
we probably
would not have
static problems!**


**If we did not have
insolated
conductors we
probably would not
have
static problems!**

Preventing Electrostatic Damage

Electrostatic Protected Area (EPA)

- ◆ **A grounded static dissipative work surface**
- ◆ **A grounded ESD wrist strap and cord**
- ◆ **Sign indicating “EPA”**





CAUTION

ESD PROTECTED AREA

**USE ELECTROSTATIC
DISCHARGE PROTECTIVE
HANDLING PROCEDURES**

9905-01-342-3044

Working in EPA

- ◆ Check wrist strap & cord
- ◆ 2 foot rule
- ◆ No food, no drink
- ◆ Only ESD trained
- ◆ Work directly on ESD mat
- ◆ Visitors need to be grounded
- ◆ Clean
- ◆ Electronic Devices always protected

The 3 Commandments of ESD

- ♦ **All electronic devices are considered ESD sensitive**
- ♦ **Never expose electronic devices to electrostatic fields**
- ♦ **Never touch (or discharge to) the leads or terminals of an electronic device**

EPA

- ◆ **A grounded static dissipative work surface**
- ◆ **A grounded ESD wrist strap and cord**
- ◆ **Sign indicating “ESD safe area”**



Preventing Static Charge Damage

- ◆ **Remove non-essential insulators from EPA's**
- ◆ **Provide conductive barriers (Faraday cage) for ESD sensitive devices**
 - **Example: Place ESD sensitive devices and circuit cards in *MIL-B-81705 TY3* ESD barrier bags**
- ◆ **Provide conductive paths to prevent static charge build up by**
 - Wearing a grounded ESD wrist strap and cord
 - Working on a grounded Static Dissipative ESD mat
 - » **Effective on conductive surfaces only**
 - » **Little or no effect on nonconductive surfaces**
- ◆ **Neutralize the charges on insulators by using air ionizers within EPA's**

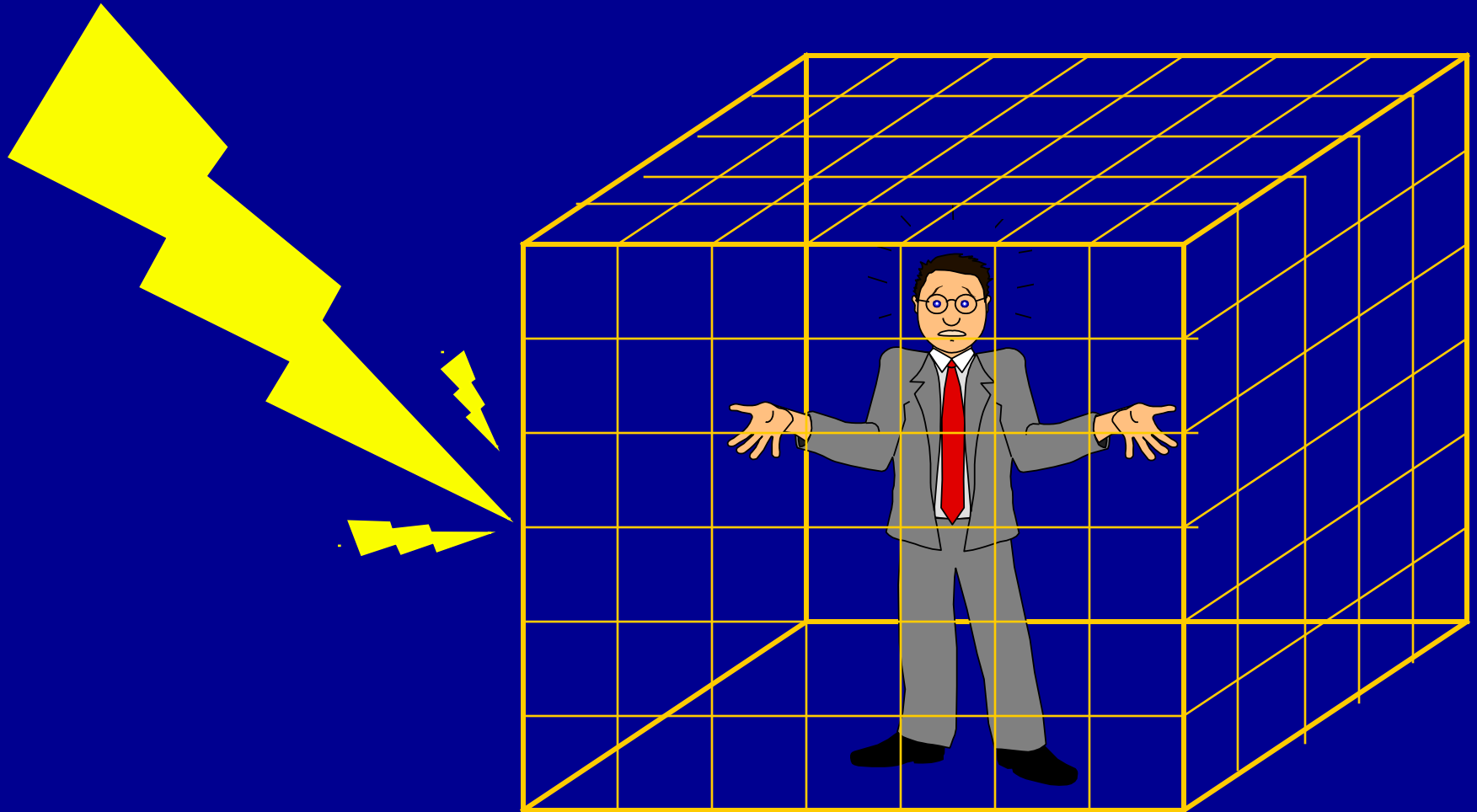
ESD Protection Requirements

- ◆ **EPA for handling all electronic devices**
- ◆ **Proper ESD packaging and storage all electronic devices**
- ◆ **ESD training for all personnel including visitors**

Packaging and Storage

- ◆ **Know your ESD packaging materials**
- ◆ **Understand how to provide ESD packaging protection and basic ESD storage principles**

The Faraday Cage











Packaging Material

Document Envelopes



Plastics



Anti Static Material (Type II)



Nickel Shielded Material (Type III)



Conductive Material (Type 1)



Aluminum Layer (Type 1)



Tote Boxes



Fast Packs





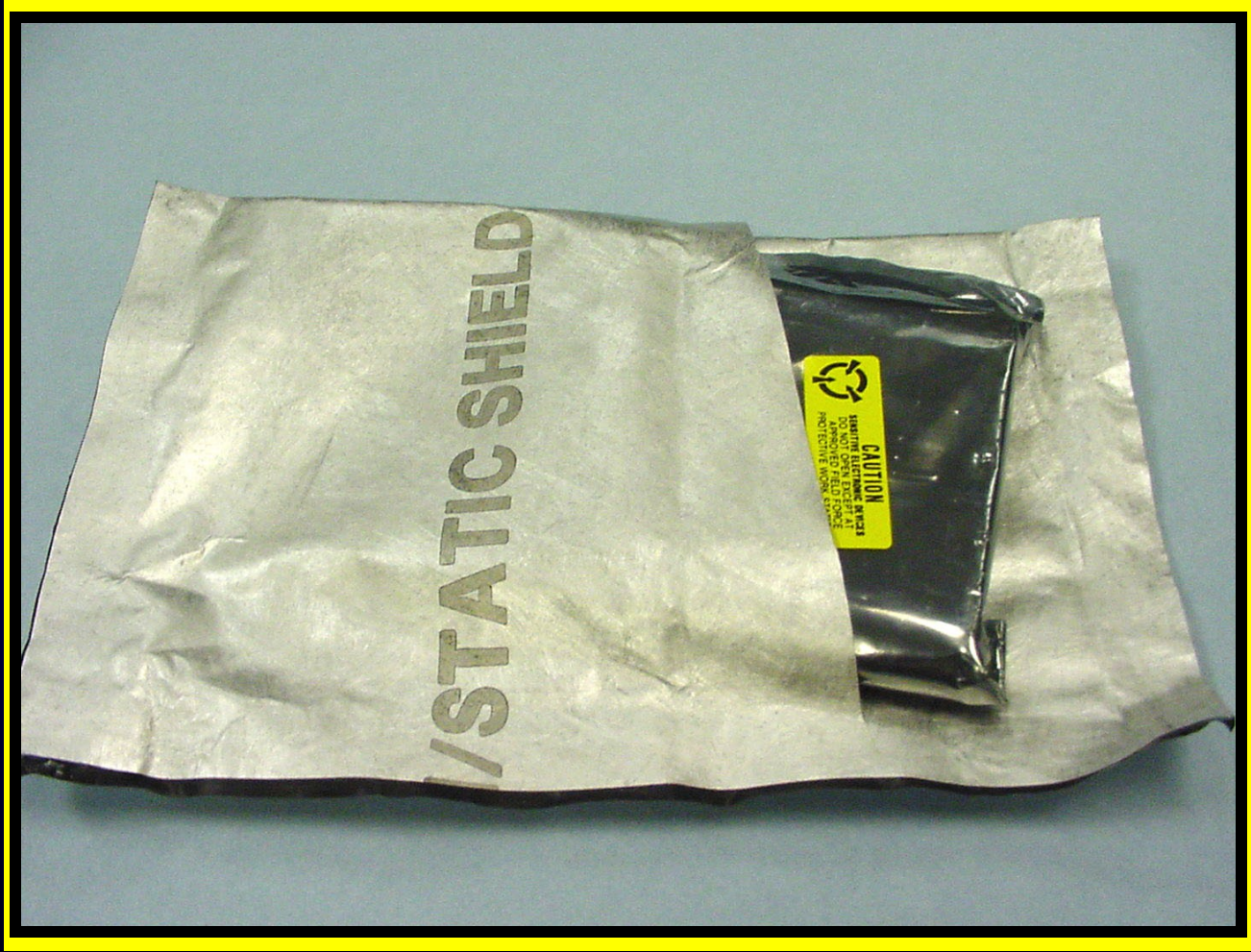






CAUTION
SENSITIVE ELECTRONIC DEVICE
DO NOT OPEN EXCEPT AT
APPROVED LOCATION
PROTECTIVE WORK IN PROGRESS

721538-801
COND F
B/57
/1F





**When shipping ESD sensitive
items**

use one of the following methods

- ◆ **Enclosed in a Type III static shielding bag**
- ◆ **Wrapped or enclosed in Type II material or bag then sealed in a Type I or III bag**

MIL-B-81705 TY3

8105-01-386-3863 ESD BARRIER 4 X 4 ZIPLOCK

8105-01-386-3874 ESD BARRIER 4 X 8 ZIPLOCK

8105-01-386-3869 ESD BARRIER 6 X 10 ZIPLOCK

8105-01-386-3899 ESD BARRIER 8 X 10 ZIPLOCK

8105-01-386-3862 ESD BARRIER 8 X 12 ZIPLOCK

8105-01-385-5375 ESD BARRIER 11 X 14 ZIPLOCK

8105-01-386-3868 ESD BARRIER 12 X 16 ZIPLOCK

8105-01-390-1106 ESD BARRIER 12 X 23 ZIPLOCK

8105-01-390-1108 ESD BARRIER 22 X 23 ZIPLOCK

8105-01-386-3865 ESD BARRIER / BUBBLE 6 X 10 ZIPLOCK

8105-01-386-3867 ESD BARRIER / BUBBLE 8 X 10 ZIPLOCK

**8105-01-385-6281 ESD BARRIER / BUBBLE 10 X 12
ZIPLOCK**



PINK - POLY
Does not provide ESD
Protection!!!



Conductive Caps Provide ESD Protection



Black Boxes

- ◆ When all connectors are covered with conductive caps a Faraday cage is created that protects the inner subassemblies from static generating sources.

Only then can “Black Boxes” be transported wrapped with non-conductive, standard shipping material.

FEDLOG

- ♦ Enter Cage Code 20999
- ♦ Enter P/N 4270* = Circular caps
- or
- ♦ Enter P/N 4272* = D Type caps
- ♦ Search

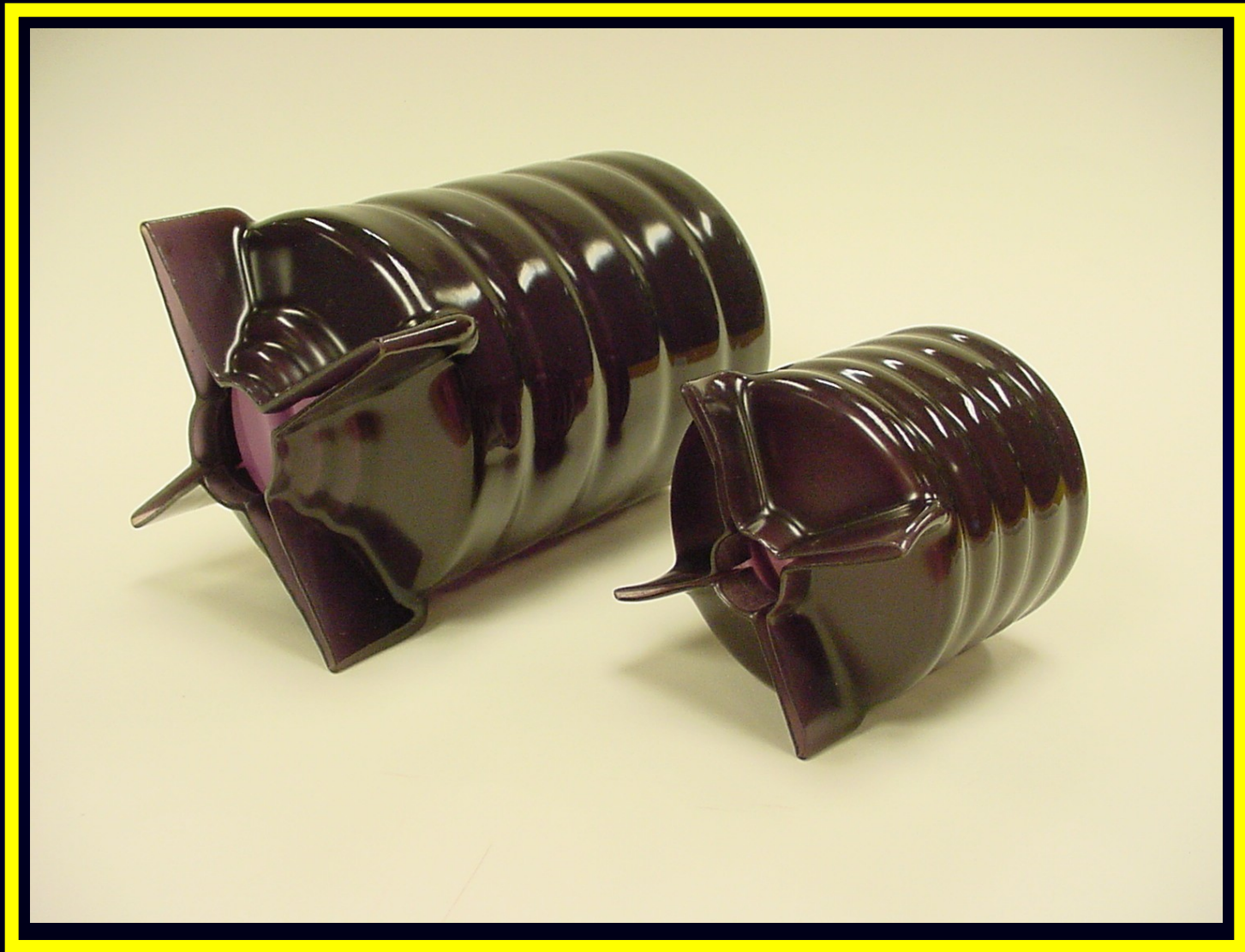
Circular ESD Caps

5935-01-303-7475	4270-10R	20999		5935-01-304-4158	4270-28Y	20999
5935-01-304-4150	4270-10Y	20999		5935-01-304-0466	4270-32R	20999
5935-01-304-0457	4270-12R	20999		5935-01-304-4159	4270-32Y	20999
5935-01-304-4151	4270-12Y	20999		5935-01-304-0467	4270-36R	20999
5935-01-304-0458	4270-14R	20999		5935-01-304-4160	4270-36Y	20999
5935-01-304-4166	4270-14Y	20999		5935-01-304-0468	4270-40R	20999
5340-00-200-5904	4270-16R	20999		5935-01-304-4161	4270-40Y	20999
5935-01-304-4152	4270-16Y	20999		5935-01-304-4163	4270-44R	20999
5935-01-304-0460	4270-18R	20999		5935-01-304-4162	4270-44Y	20999
5935-01-304-4153	4270-18Y	20999		5935-01-304-4165	4270-48R	20999
5935-01-304-0461	4270-19R	20999		5935-01-304-4164	4270-48Y	20999
5935-01-304-0462	4270-20R	20999		5935-01-303-7471	4270-4R	20999
5935-01-304-4154	4270-20Y	20999		5935-01-378-3550	4270-4Y	20999
5935-01-304-0463	4270-22R	20999		5935-01-350-7478	4270-5R	20999
5935-01-304-4155	4270-22Y	20999		5935-01-304-4148	4270-5Y	20999
5935-01-304-0464	4270-24R	20999		5935-01-303-7472	4270-6R	20999
5935-01-304-4156	4270-24Y	20999		5935-01-303-7473	4270-8R	20999
5935-01-304-4157	4270-25Y	20999		5935-01-304-4149	4270-8Y	20999
5935-01-304-0465	4270-28R	20999		5935-01-303-7474	4270-9R	20999



“D” Shell ESD Caps

5935-01-378-3555	4272-15P	20999
5935-01-378-2519	4272-15S	20999
5935-01-378-3609	4272-25P	20999
5935-01-378-2601	4272-25S	20999
5935-01-378-3674	4272-37P	20999
5935-01-378-2718	4272-37S	20999
5935-01-378-3728	4272-50P	20999
5935-01-350-5755	4272-50S	20999
5935-01-378-2812	4272-9P	20999
5935-01-378-2437	4272-9S	20999



Molded Devices P/N	FSN	Size (inches)
901200-	5935-01-388-	(Dia x Length)
15-17	6527	1.5 x 1.75
15-22	7088	1.5 x 2.25
15-27	7109	1.5 x 2.75
15-32	7051	1.5 x 3.25
15-37	5524	1.5 x 3.75
20-17	7132	2.0 x 1.75
20-22	5584	2.0 x 2.25
20-27	5825	2.0 x 2.75
20-32	6523	2.0 x 3.25
20-42	5409	2.0 x 4.25
25-22	7169	2.5 x 2.25
25-27	7113	2.5 x 2.75
25-32	7160	2.5 x 3.25
25-37	2937	2.5 x 3.75
25-42	6495	2.5 x 4.25
25-52	7148	2.5 x 5.25
25-72	2897	2.5 x 7.25
30-35	7170	3.0 x 3.5
30-45	7134	3.0 x 4.5
35-35	7039	3.5 x 3.5
35-55	7082	3.5 x 5.5
40-35	6528	4.0 x 3.5
60-65	7080	6.0 x 6.5

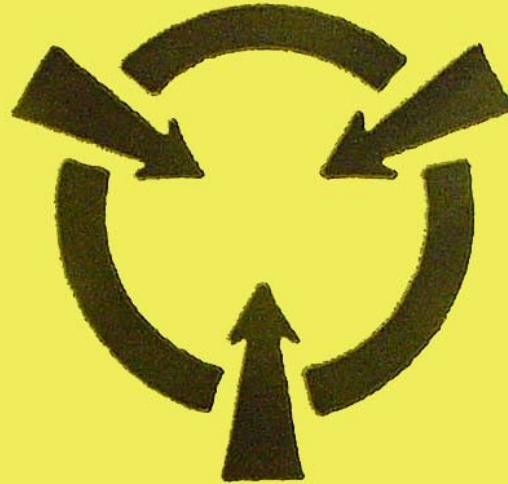
Preventing Static Charge Damage

- ◆ **Remove non-essential insulators from EPA's**
- ◆ **Provide conductive barriers (Faraday cage) for ESD sensitive devices**
 - **Example: Place ESD sensitive devices and circuit cards in *MIL-B-81705 TY3* ESD barrier bags**
- ◆ **Provide conductive paths to prevent static charge build up by**
 - Wearing a grounded ESD wrist strap and cord
 - Working on a grounded Static Dissipative ESD mat
 - » **Effective on conductive surfaces only**
 - » **Little or no effect on nonconductive surfaces**
- ◆ **Neutralize the charges on insulators by using air ionizers within EPA's**

MIL-STD-129N

“Exterior and Intermediate container label”

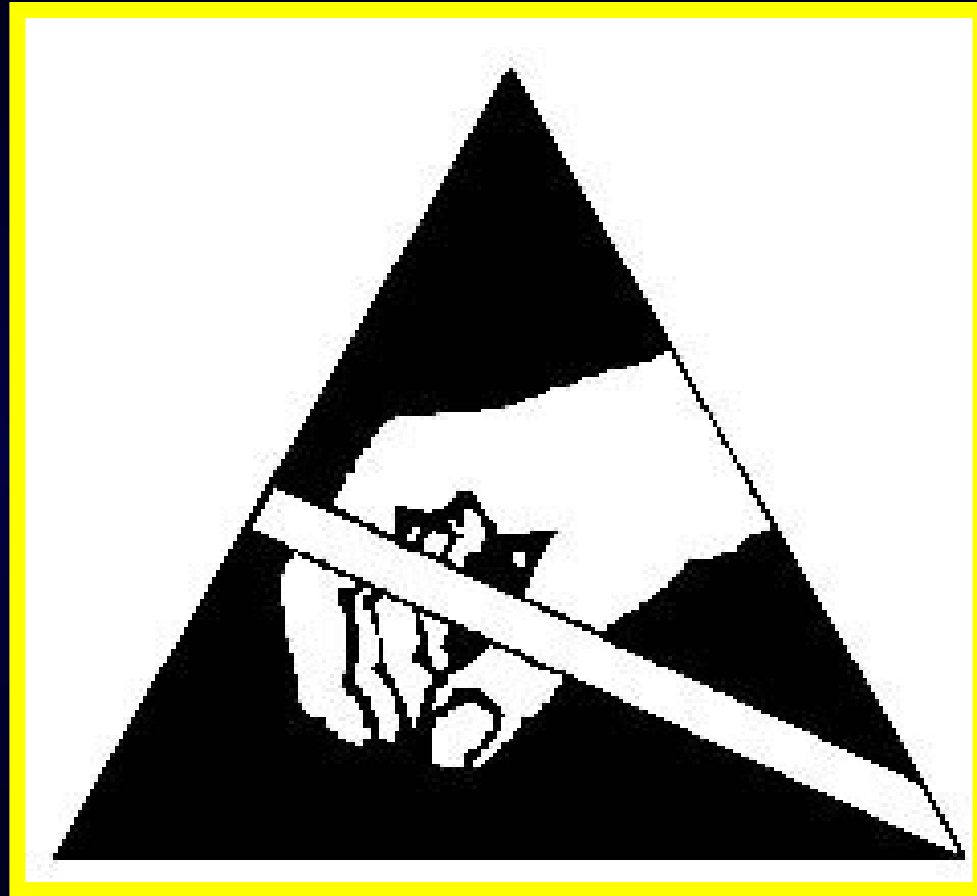




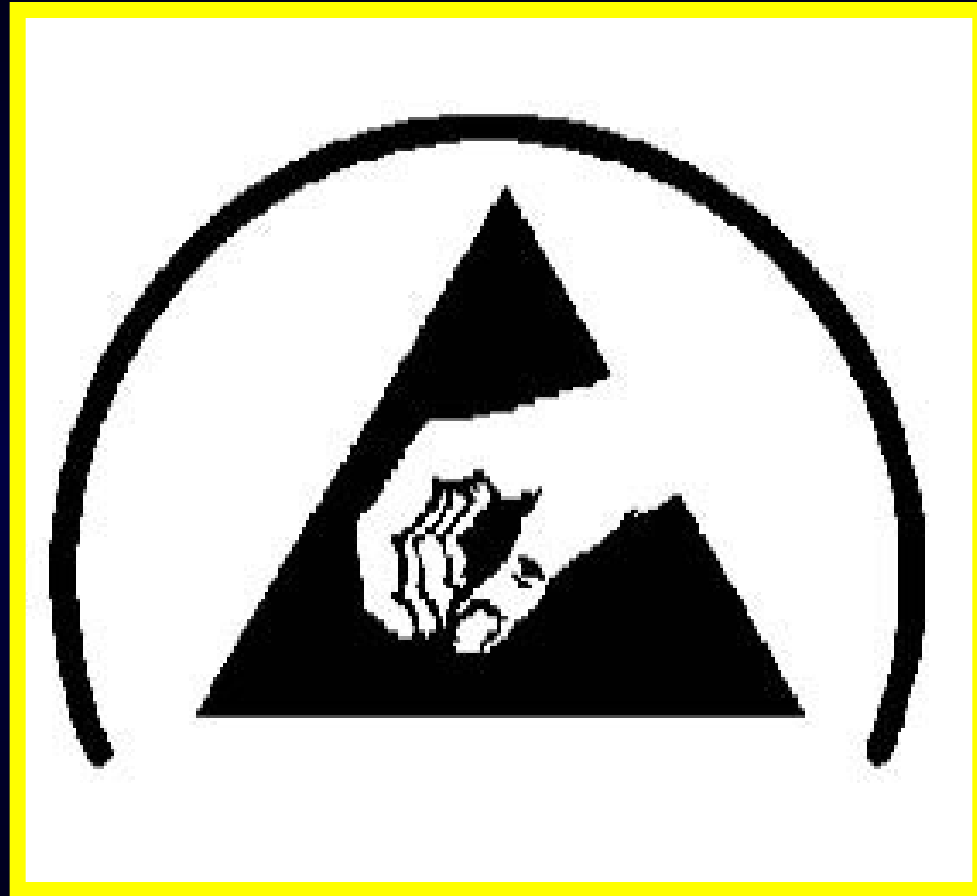
CAUTION

SENSITIVE ELECTRONIC DEVICES
DO NOT SHIP OR STORE NEAR STRONG
ELECTROSTATIC, ELECTROMAGNETIC,
MAGNETIC OR RADIOACTIVE FIELDS

ESD Susceptibility Symbol



ESD Protective Material Symbol



Electrostatic Protected Area

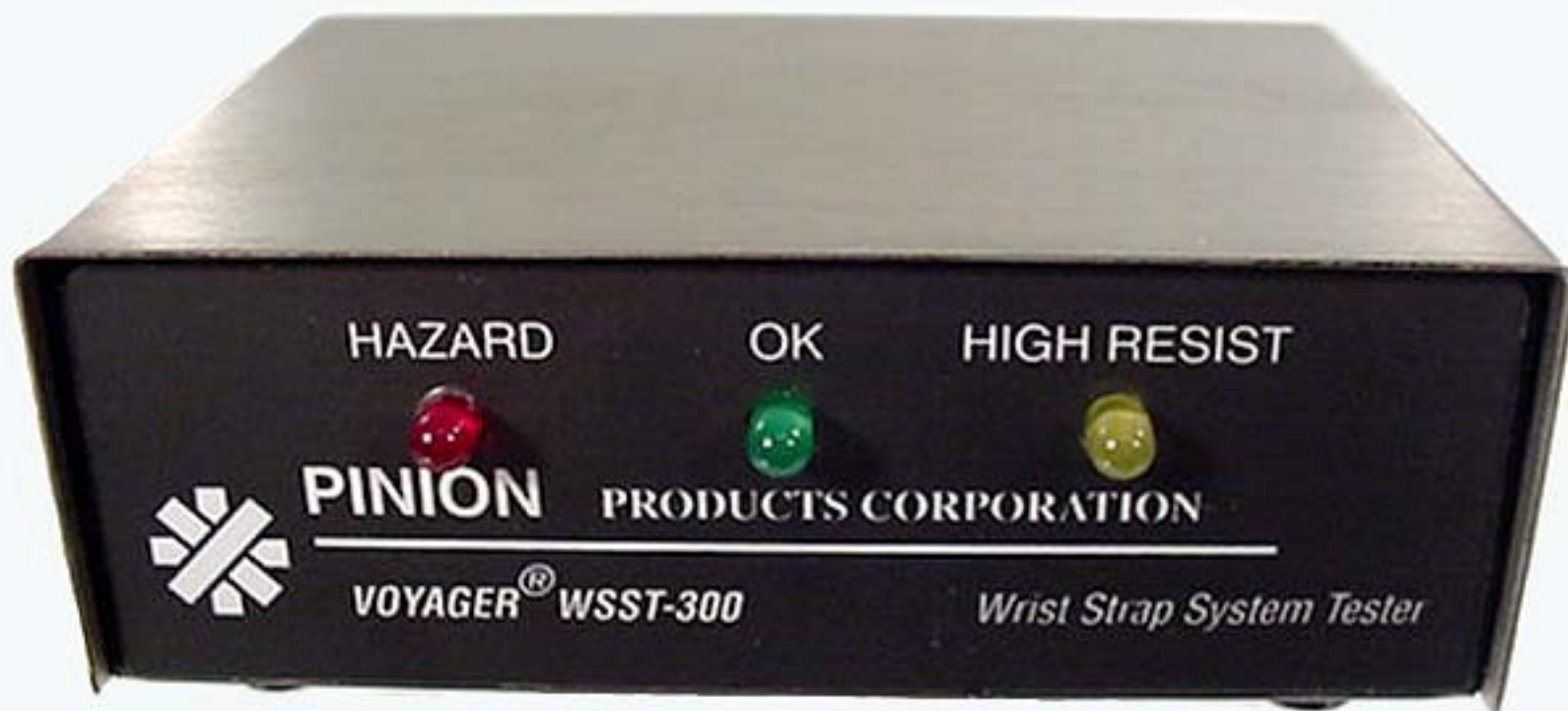
ESD Common Point Ground



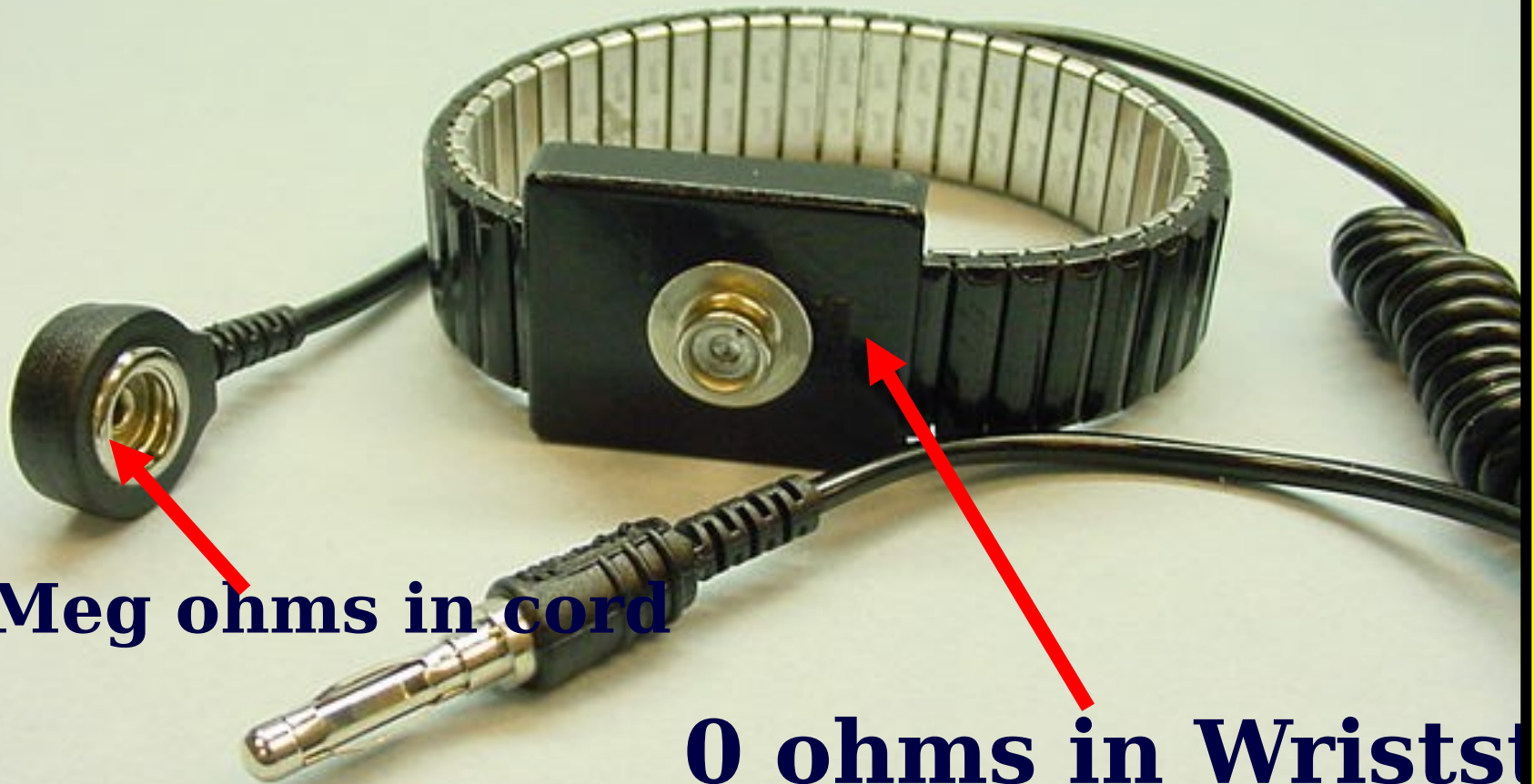








Wescorp Wriststrap and Cord

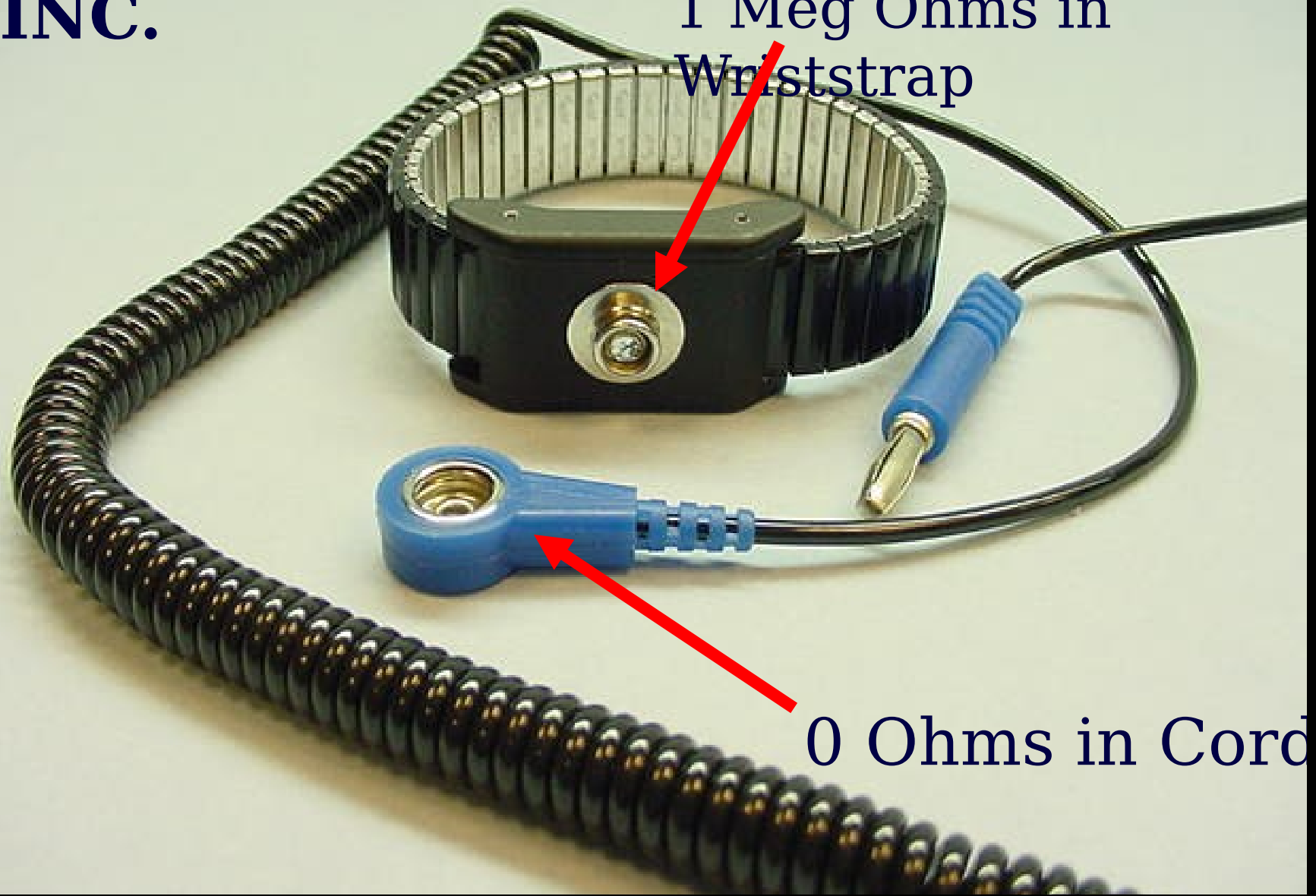


1 Meg ohms in cord

0 ohms in Wriststrap

NU-CONCEPT SYSTEMS, INC.

1 Meg Ohms in
Wriststrap



0 Ohms in Cord

2 Meg Ohms Total!!

NU-CONCEPT
WRISTSTRAP

WESCORP
CORD



DANGER !!!!!

**WESCORP
WRISTSTRAP**

**0 Ohms in
Wriststrap**

0 Ohms in Cord

**NU-CONCEPT
CORD**





5920012354141

5920-01-235-4141

CAGE 56742

P/N SWB40-MC7

DISCHARGER ELECTROS

01 EACH

SP0920-99-M-1371

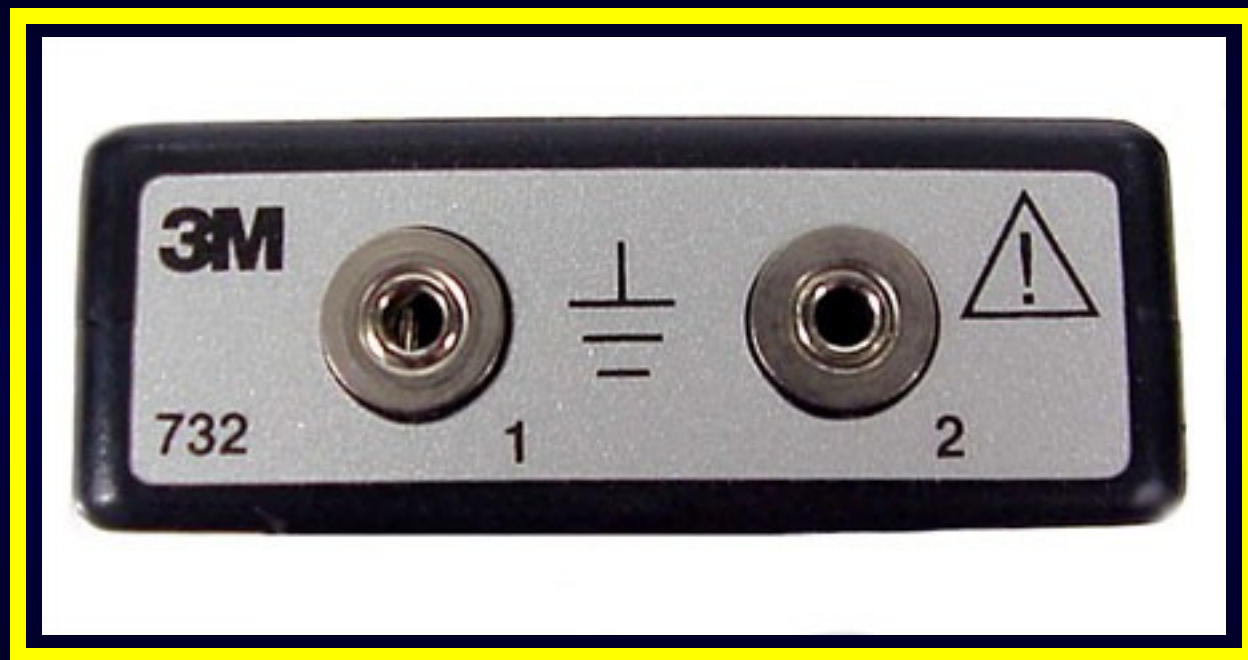
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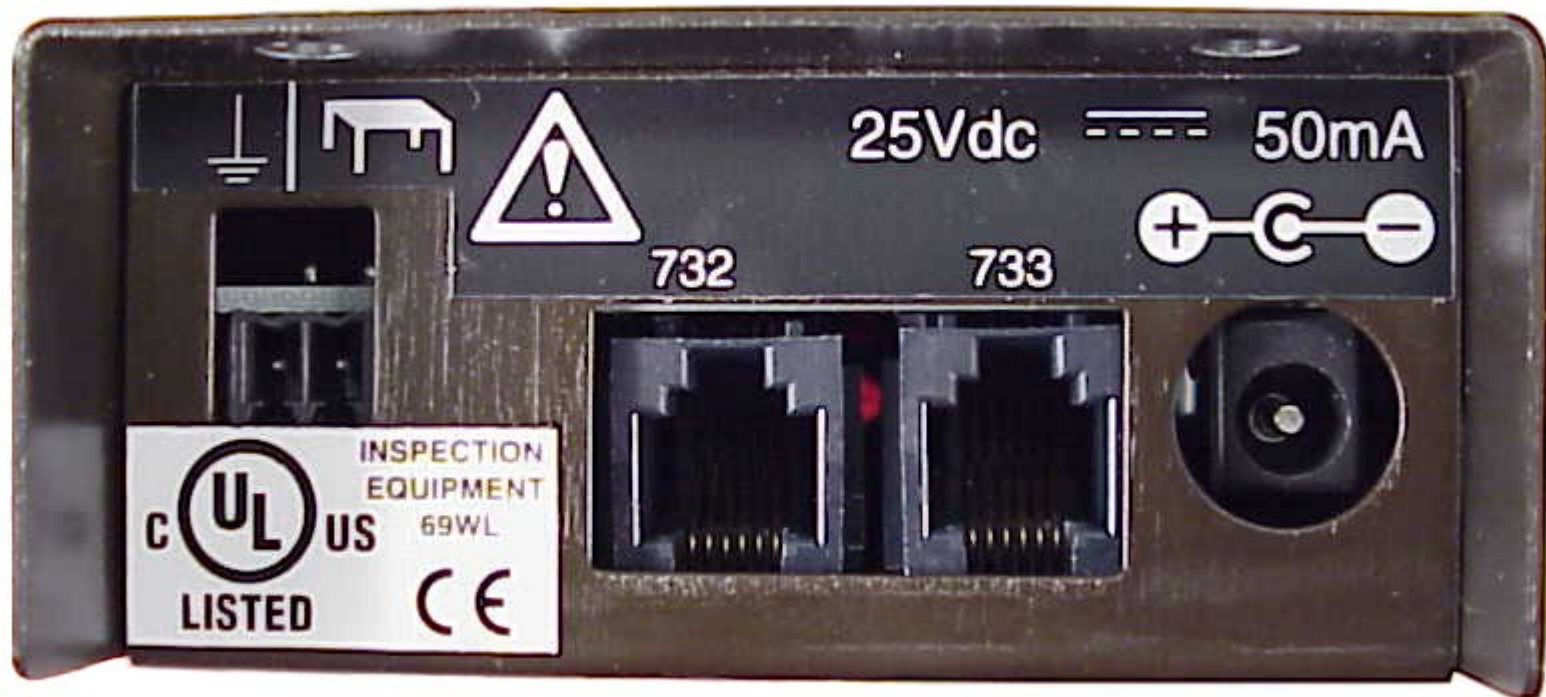


3M Model 724 Constant Monitor
System

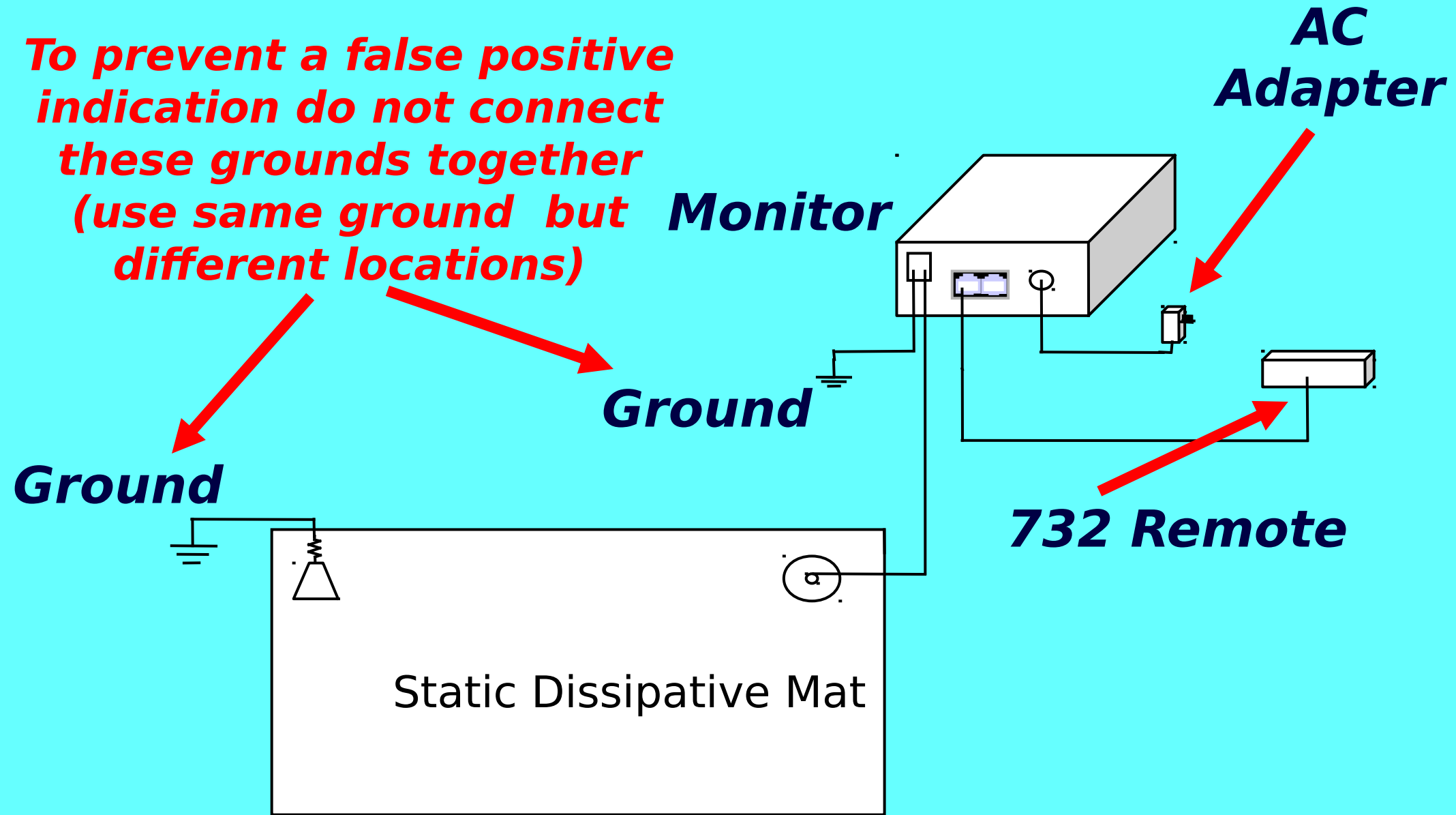








To prevent a false positive indication do not connect these grounds together (use same ground but different locations)



Connect ESD Constant Monitor as shown in the above block diagram

3M 724 Workstation Monitor Verfication Kit
Model 724VK

The Model 724 Workstation Monitor cannot be recalibrated after the initial factory calibration. Follow the procedure outlined in the 724 Instruction Manual to verify proper operation. Use of this kit eliminates the need of a resistance substitution box when testing the wrist strap input connections.

Electronic Handling & Protection Division
Austin, TX 78726-9000

Made U.S.A.

Use plugs 1 through 4 (10 megohms resistance selection) on wrist strap input.

Use plugs 1, 2, 5, & 6 (35 megohms resistance selection) on wrist strap input.

PLUG #1 GREEN LAMP ON YELLOW LAMP FLASHING
(1.33 Megohms)

PLUG #2 GREEN LAMP ON (1.69 Megohms)

PLUG #3 GREEN LAMP ON (8.45 Megohms)

PLUG #4 RED WRIST STRAP LAMP ON, ALARM ON,
GREEN OK LAMP OFF (11.5 Megohms)

PLUG #5 GREEN LAMP ON (29.4 Megohms)

PLUG #6 RED WRIST STRAP LAMP ON, ALARM ON,
GREEN OK LAMP OFF (40.2 Megohms)

NOTE: RESISTORS ARE +/- 1%





**8510-01-492-
3313**

- ◆ **8510-01-492-3310 / "ICL-1-Tube"**
(Box of 50 1 oz. Tubes)
- ◆ **8510-01-492-3311 / "ICL-8-ESD"**
(8 oz. ESD safe Bottle)
- ◆ **8510-01-492-3313 / "ICL-16-ESD"**
(16 oz. ESD safe pump Bottle)

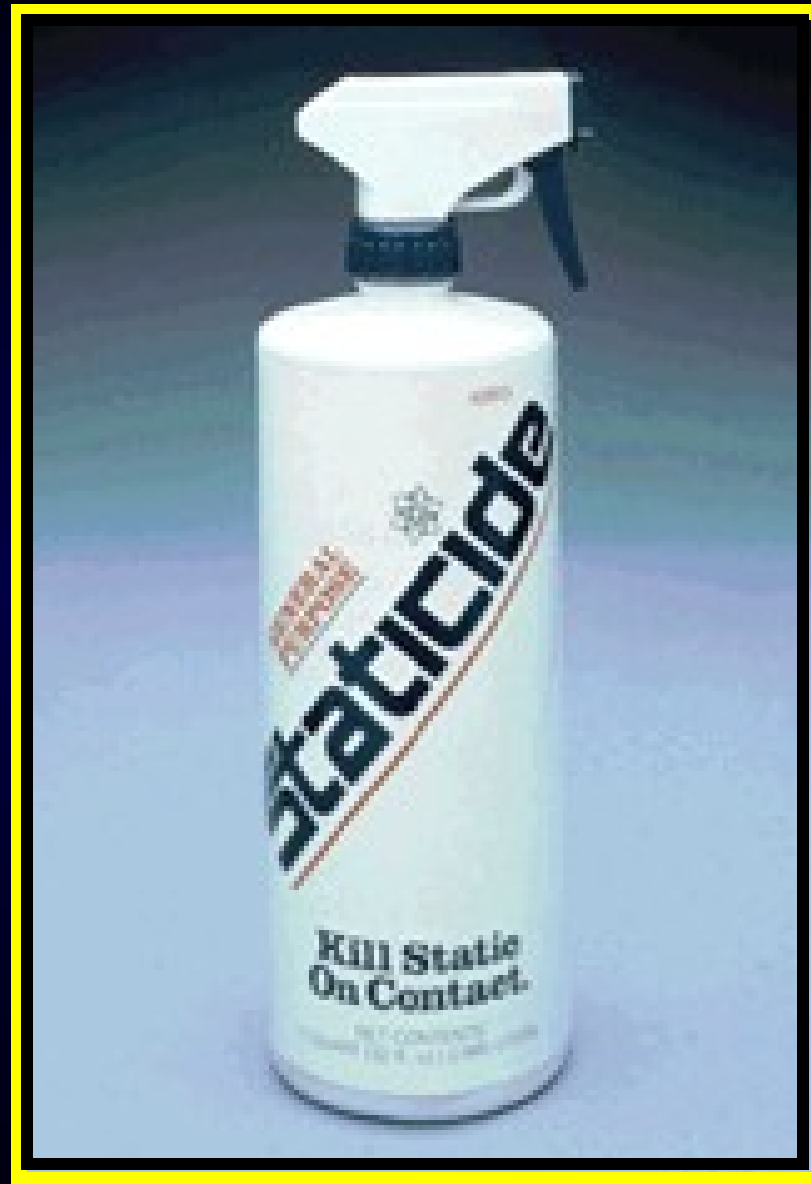


6580-01-283-



**1350-01-264-
6898**





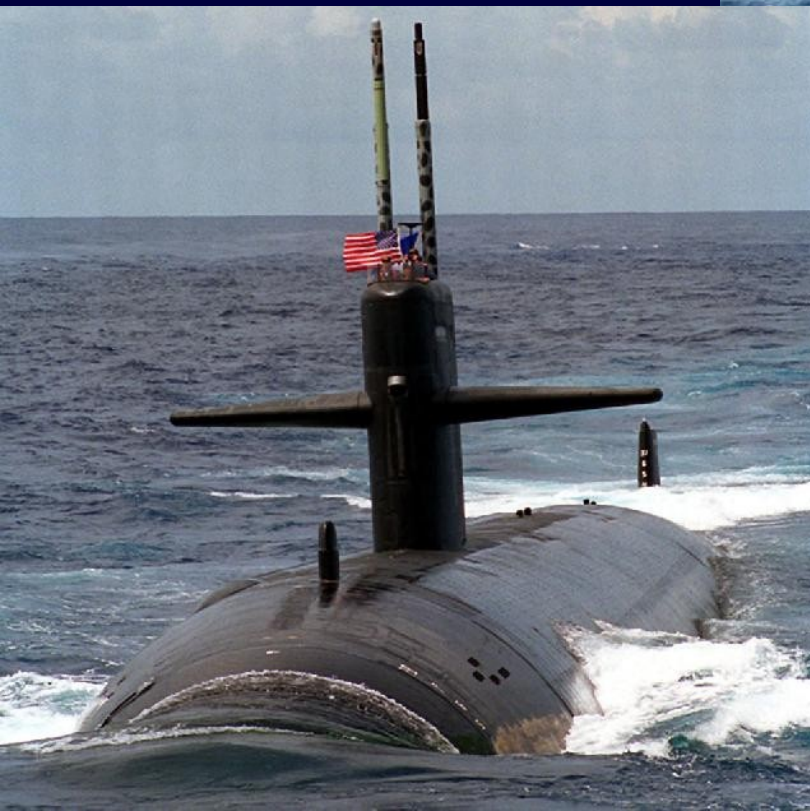


NOT PERMITTED IN EPA's

- ◆ **Styrofoam / Plastic Cups**
- ◆ **Polyethylene Envelopes, Sheets, Bags etc..**
- ◆ **Common Bubble-Pack and Packaging Foam**
- ◆ **Scotch Tape**
- ◆ **Rubber Pads**
- ◆ **Plastic Tote Boxes**
- ◆ **Unnecessary Insulating Materials in General**

Safety Precautions

- ♦ **All antistatic work surfaces must be connected to a common ground through a resistance of :**
 - » **1 Meg ohm minimum**
 - » **2 Meg ohm maximum**
- ♦ **Never connect personnel directly to common ground**
- ♦ **Power tools must be transformer or D.C. isolated**
- ♦ **No plastic items on the work surface**









ARE THERE ANY



QUESTIONS



“WP” Norris

- ◆ **Code 6083 Bldg 3330 North
300 Hwy 361
Crane, IN 47522**
- ◆ **812.854.3192 FAX: 854.3855
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- ◆ **norris_w@crane.navy.mil**